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Gait, Strength, And Balance Training For A 43-Year-Old Male Following An Acute Right Middle Cerebral Artery Stroke: A Case Report

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The patient signed an informed consent form allowing the use of medical information and photographs taken for the case report. He was informed on the institution's policies regarding the Health Insurance Portability and Accountability Act (HIPAA).

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Key Words: Right Middle Cerebral Artery Stroke, Gait Training, Balance Training, Strength Training.

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Abstract

Background and Purpose: Although many patients who have had a stroke receive inpatient rehabilitation treatment, there is limited literature that investigates the interventions utilized to treat this population. The purpose of this case study was to describe the inpatient rehabilitation treatment interventions including body weight supported treadmill training (BWSTT), functional electrical stimulation (FES), balance, and lower extremity (LE) strengthening on a patient with a sub-acute right middle cerebral artery (R MCA) stroke.

Case description: The patient was a 43-year-old male who recently had a R MCA stroke. He presented with significant expressive aphasia, left-sided hemiparesis, balance and transfer deficits, and impulsivity. His plan of care incorporated BWSTT, FES, balance and cardiovascular training, LE strengthening, education, and over-ground walking. The outcome measures utilized were the Functional independence measure (FIM), and the Postural Assessment Stroke Scale (PASS). His reflexes, gross motor strength, and sensation were also assessed.

Outcomes: The patient demonstrated improvements in his left LE (LLE) strength from averaging 2/5 to 4+/5 on manual muscle testing. He improved his independence with transfers, and improved gait mechanics and balance. His PASS score improved from 6/36 to 34/36 and his FIM score from 44/126 to 92/126 by discharge.

Discussion: The physical therapy (PT) interventions that targeted LE strengthening, gait, and balance training were beneficial. This patient's recovery was affected by his immediate treatment, access to equipment and technology, and having an interdisciplinary team. Further investigation should be conducted in different inpatient rehabilitation facilities, for patients with chronic stroke, and for patients in different PT settings.

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Introduction/Background and Purpose

A cerebrovascular accident (CVA), also commonly known as a stroke, is a medical condition that affects 795,000 people each year and is the third leading cause of death in the United States.[1] A stroke is caused by an ischemic or hemorrhagic event affecting arteries that lead to the brain causing them to burst or be occluded.[1] The middle cerebral artery (MCA), supplies oxygenated blood to the frontal, temporal, and parietal lobes of the brain, which include primary motor and sensory areas. The MCA is the most commonly occluded artery involved in a stroke.[2]

The four most common medical conditions associated with an increased risk of having a stroke are high blood pressure, diabetes, heart disease, and previous strokes including transient ischemic attacks (TIA).[1] Impairments associated with strokes are hemiparesis, loss of sensation in the face or extremities, difficulties with speech, vision, and gait.[3] *Hemiparesis* is significant weakness on one side of the body. Inpatient rehabilitation facilities (IRF) can offer physical therapy (PT), occupational therapy (OT), and speech language pathology (SLP) for individuals who have these impairments.

Several PT interventions are utilized for patients following a stroke to address gait and balance deficits. Interventions can include body weight support treadmill training (BWSTT) in combination with functional electrical stimulation (FES) to improve gait mechanics, and balance training to enhance reactive stepping to decrease fall risk.[4,5] These interventions can improve safety, balance, gait mechanics and cadence; which can overall promote independence.

There are several studies that have documented different interventions available to treat patients with chronic stroke in an outpatient setting; yet, there are limited research articles regarding IRF PT interventions for people younger than 65-years-old who have had an acute stroke. The purpose of this case report was to describe the PT management of intensive IRF PT

interventions including gait, strength, and balance training for a 43-year-old Caucasian male who had an acute R MCA stroke.

Patient History and Systems Review

The patient consented to be the subject of this case report. He was a 43-year-old Caucasian male who experienced a R MCA stroke one week prior to his admittance to an IRF. Prior to arriving at the IRF, the patient was admitted to an inpatient hospital because of an acute onset of aphasia. His computed tomography (CT) scan imaging showed he had an occlusion of his right M1 artery with a large penumbra in his R MCA distribution. The patient received tissue plasminogen activator (tPA) and a thrombectomy once the imaging was confirmed. An angiogram showed an underlying stenosis clot, ultimately causing the R MCA stroke. The imaging and the patient presentation ruled out any other differential diagnosis.

According to his physician, the etiology of his stroke was cryptogenic. The patient had a past medical history of right knee and shoulder surgery, and a possible TIA at age 25, of which the relevant past interventions are unknown. His comorbidities consisted of smoking two packs of cigarettes per day, a BMI of 40.1, and prior excessive alcohol consumption. The patient incurred a morbilliform rash on his trunk and upper thighs, potentially from the drugs he was given in the acute care inpatient hospital; thus, all current medications were discontinued except aspirin. A complete list of medications can be found in Appendix 1. Due to his expressive aphasia, a clear family medical history was not obtained. The patient was self-employed as a roofer. He lived in a single-story home with his wife.

The initial evaluation (IE) at the IRF was six days post-stroke. A complete systems review can be viewed in Table 1. Secondary to the stroke, the patient presented with hemiparesis of his left upper extremity (LUE) and left lower extremity (LLE), and impaired sensation and proprioception in his LLE. Complete examination results can be viewed in Tables 1 and 2.

The patient required a one-person maximum assist to transfers from his manual wheelchair to the therapy mat. Once the patient was in supine on the mat, the PT examined his LE active range of motion (AROM) and passive range of motion (PROM), as described by Norkin et al.[6-8] The PT conducted a thorough gross motor LE strength assessment, afterwards documenting the strength by grades as described by Kendall et al,[9] followed by a LLE sensation examination by methods described by O'Sullivan et al.[10]

The patient could not stand independently, but could navigate his manual wheelchair with minimal assistance. The patient's main limitations were his deficits in his balance, bed mobility, cognition, transfers, coordination, and gait. He also had impairments with judgement, activity tolerance, speech, and sensation. Complete IE results can be viewed in Tables 1 and 2.

The patient's chief complaints were his expressive aphasia and inability to walk. The patient's perspective regarding his diagnosis was his concern that he may never achieve his goal of becoming independent. The patient was a good candidate for this case report because of his significant motor and speech impairments and his determination to recover. The plan for the examination included tests and measures such as: National Institute of Health Stroke Scale (NIHSS), the Postural Assessment Scale for Stroke (PASS), the Functional Independence Measure (FIM), gross LE muscular strength assessment, and neurological screening.

Examination- Tests and Measures

The following tests and measures were conducted to evaluate the patient's initial deficits and to monitor his progression: NIHSS, FIM, PASS, MMT, and an assessment of sensation, spasticity, and deep tendon reflexes. The data regarding the reliability and validity for the NIHSS, FIM, PASS, MMT, and Modified Ashworth Scale can be viewed in Appendix 2.

The NIHSS is a systemic assessment that is used to quantify the severity of a stroke. The purpose of this test is to determine an appropriate treatment plan and generate a predictive

patient outcome.[11] The patient scored 11/42, which classified his stroke as being moderate.[11] The patient results and the interpretation of this assessment can be viewed in Table 3. The FIM is an assessment used to monitor a patient's ability to perform activities of daily living (ADL) and their functional independence. The purpose of this outcome measure is to track the patient's progression and determine their length of stay (LOS).[12] The FIM was used to assess the patient on IE, day 3, and at discharge. The totality of the assessment was conducted via the PT, OT, and SLP. The patient's initial FIM score was 44/126, with higher values indicating greater functional independence. The patient's complete FIM results can be viewed in Table 4. The last outcome measure completed was the PASS. The PASS is a performance measure give to patients who have had a stroke. The purpose of the PASS is to assess a patient's ability to transfer, balance, and maintain postural control.[13] The patient initially scored a 6/36. A higher score indicates increased ability to perform transfers, achieve better balance, and maintain better postural control.[13] A complete list of the patient's results can be viewed in Table 5.

The patient's gross motor LE strength was assessed and was graded according to MMT scores described by Kendall et al.[9] MMT is an assessment used to rate a patient's muscular strength on a 0-5 scale.[9] The purpose of this assessment for this patient was to monitor the progression of his muscular strength. Complete results and a definition of different MMT scores can be viewed in Table 2.

Lastly, the patient's neurological testing was completed by his PT examining his LE sensation, spasticity, and deep tendon reflexes, as described by O'Sullivan et al.[10,14] The patient's sensation examination followed a dermatomal pattern, indicating impairments in his light touch and proprioception in L3-4, his mid medial thigh and medial calf on his LLE. The patient's spasticity was evaluated with the Modified Ashworth Scale.[15] His results indicated a level two, which meant he had increased tone for most of his PROM in his left ankle. Additionally, the

patient's deep tendon reflexes on his LLE were examined. He scored a 1+ which indicated a slight but definite response.[16] The complete results of his examination tests and measures, and his outcome measures can be viewed in Tables 2-5.

Clinical Impression: Evaluation, Diagnosis, Prognosis

After the evaluation, the initial impression based upon the patient's medical diagnosis was consistent with the examination findings. The patient continued to be an appropriate candidate for this report due to his left hemiparesis and expressive aphasia. The proposed plan of care included PT, OT, and SLP. The PT plan of care was to improve his LE strength, gross motor activation and control, walking ability, balance, and transfer ability. These interventions would be applied to assist the patient in achieving his goal of becoming independent and walking again.

The patient's medical diagnosis was an *Acute R MCA*, ICD-10: 345636015. Secondary to his stroke, the patient was also diagnosed with: *Adjustment disorder with anxiety* (F43.22), *Rash and other non-specific skin eruption* (R21), and *Shortness of breath* (R06.02). His R MCA was confirmed by his medical imaging. The patient's physical therapy diagnosis was *Left hemiparesis*, ICD-10: I69.354.

The patient's PT prognosis was good. The prognostic rationale included being a young active male, which significantly improved his chances of a better functional outcome compared to if he had been older than age 65.[17] Another influencing prognostic factor was his motivation to regain independence. The patient's barriers consisted of his impulsivity and impatience with his slow recovery. The patient's medical prognosis was fair due to the patient's comorbidities such as having a high BMI, a previous TIA, and tobacco use disorder.

The patient was admitted to an IRF for four weeks. The patient's PT was 90 minutes per day, five days a week. The plan for the PT interventions included gait and balance training with BWSTT and over-ground walking, high intensity interval training with therapeutic exercises, and

the incorporation of neuromuscular re-education using the Bioness L-300 (Bioness L300 Go, Bioness Inc, USA) and electrotherapy technology. At discharge, the plans for additional testing and re-evaluation were the FIM and PASS to document his progress. Results can be viewed in Tables 4 and 5. After a consultation with his attending medical doctor, the plans for referral were for outpatient PT with a specialization in neurological rehabilitation. A complete list of the patient's interventions and progression can be viewed in Appendices 3 and 4. The patient was involved in creating his goals for PT, which are outlined in Table 6.

Intervention and Plan of Care

The patient's progression was discussed weekly by the interdisciplinary team. The patient's diagnostic imaging from the acute care hospital were transferred to the IRF. The patient was evaluated by an interdisciplinary team, which consisted of a medical doctor, PT, OT, and SLP, and coordinated by his case manager. The interdisciplinary team discussed the patient's progress, prognosis, plan of care, and the patient's long and short-term goals weekly. All documentation was completed via electronic medical records (EMR) to ensure easy accessibility to everyone on the interdisciplinary team. The patient was compliant with all the PT treatment sessions.

During the IRF evaluation, the patient was informed of the plan of care and his expected time of discharge. The patient was given a home exercise program (HEP) to perform twice a day for the next few weeks while in the IRF. Upon discharge, the patient was given specific instructions by his PT regarding: ambulation, stairs and curb navigation, bed mobility, and weight bearing. The assistive device recommended for the patient was a manual wheelchair for long distances, and a hemi-walker for short distance ambulation. The patient was instructed to walk and to navigate stairs/curbs with someone in the interim until his outpatient PT deemed fit to ensure his safety. The patient was cleared to perform all bed mobility independently and was

cleared to weight bear evenly on both LE. The patient was educated about safety and impulsivity and was recommended to follow all safety precautions given to him by his PT. The patient received a printed HEP on discharge.

The patient concurrently received occupational, physical, and speech therapy five days a week. The patient's progress was updated weekly on a mobility grid. The focus of the PT interventions were to improve his LE strength, balance, endurance, gait mechanics without and with the least restrictive assistive device, and to improve bed mobility and transfers.

The interventions progressed from supine to seated therapeutic exercises to improve LE strength and to decrease tone for functional mobility tolerance. His interventions also included gait, stair navigation, and balance training. The supine therapeutic exercises involved hip flexion and extension, hip abduction and adduction, ankle plantar and dorsiflexion, bridging, and short-arc quads over a bolster. These exercises were completed to improve the patient's LE strength, including his hip extensors, knee flexors, and ankle plantar and dorsiflexors and to enhance his gross motor activation/control and neuromuscular re-education. According to a study by Kim et al,[18] the improvements in these specific muscular groups were proven to help a patient's gait mechanics on level surfaces and can increase overall gait speed.

Once the patient began to regain strength and standing tolerance, his therapy was progressed to incorporate activities such as body weight supported (BWS) standing balance and gait training (ZeroG Gait and Balance System, ARETECH, Ashburn, VA). The standing balance included perturbations to promote his reactionary stepping to decrease his fall risk. During the balance activities in the BWS suit providing approximately 25% body weight support, the patient was asked to perform toe taps while standing on the hemiparetic LLE to enhance weight bearing tolerance and balance. A similar treatment method was analyzed, and proven to improve reactionary stepping performance, in a study conducted by Mansfield et al,[5] who researched

compensatory stepping in patients who have had a stroke. After his balance was improved, the patient was treated with body weight supported treadmill training (BWSTT) to improve his gait mechanics and cadence. This activity demonstrated carryover towards over-ground walking. BWSTT, in combination with LE exercises, were utilized based on research by Mulroy et al,[19] which prove they help elicit a quicker and more natural cadence. The patient also completed cardiovascular and reciprocal motion training on the Biodex (BioStep 2 Semi-recumbent elliptical, Biodex Medical Center, Shirley, NY) for 10-15 minutes prior to several sessions to enhance his reciprocal motion and LE strength. In a study conducted by Dunning et al,[20] they linked repetitive motion to enhancing overall mobility based on improving the central nervous system's plasticity and motor learning principles.

Once the patient had improved his standing tolerance and reciprocal motion, he completed gait training with FES provided by the Bioness L300 on his LLE to improve his dorsiflexion and increase his foot clearance during gait. The FES provides neuromuscular re-education into the patient's anterior tibialis muscle by giving an electrical stimulation to initiate dorsiflexion during swing phase of gait. Dunning et al[20] discovered an improvement in hemiparetic ambulation and faster return to independent ambulation with FES during gait training. The patient ambulated with a hemiwalker or rolling walker with the FES on his LLE. He was always in a gait belt and had a second person wheelchair follow to promote safety. The patient progressed to over-ground walking without FES or an assistive device. A complete list of the patient's PT interventions, repetitions, progression and intervention highlights can be viewed in the Appendix 3. Refer to Appendix 5 for a brief timeline of the patient's interventions during his IRF treatment.

Outcomes

The PT interventions were targeted to improve the patient's LE strength, balance, gait,

stair navigation, and ability to complete a safe transfer. After four weeks, the patient had made significant improvements in these areas. Initially, the patient's PASS and FIM scores indicated moderate impairments; by the end of his therapy, he had minimal deficits regarding his secondary impairments from his stroke. The patient's PASS score went from 6/36 to 34/36. The PASS has a meaningful clinical difference (MCD) of 2.22 points.[13] The patient's discharge score indicated significant improvement. Additionally, the patient's FIM scores improved going from 44/126 to 92/126. Complete results for the FIM and PASS can be viewed in Tables 4 and 5.

At IE, the patient was unable to walk and required maximal assistance with all transfers and bed mobility. At discharge he was able to walk with supervision using a hemi-walker with a step-through pattern for approximately 500 feet. He was able to perform transfers and bed mobility with modified independence. He improved his initial standing balance from maximum assistance to supervision with a hemi-walker. By discharge, the patient was able to achieve his goal of walking out of the IRF with the hemi-walker with supervision from his PT.

The patient's strength improved significantly for his LLE. Complete results can be viewed in Table 2. The patient demonstrated improved strength and coordination by being able to ascend and descend 12 stairs with a step-to pattern with minimal assistance. The patient's initial high tone in his left ankle had diminished significantly after his treatment at the IRF, and at discharge his left ankle tone was normal. The patient regained full sensation in his LLE including light touch, proprioception, and deep pressure.

The patient adhered to and tolerated the PT interventions and did not have any adverse or unanticipated events occur while in the IRF. The patient participated in all scheduled PT appointments. His tolerance to the interventions were assessed throughout the PT sessions by monitoring his fatigue and motivation to continue with treatment. The patient's adherence to the interventions and HEP were assessed at the beginning of each PT session by verbal affirmation

from the patient and his significant other who stayed with him in the IRF, and through his improvements and demonstration of his HEP.

Discussion

The purpose of this case report was to describe the IRF PT interventions utilized for a patient who had a sub-acute R MCA stroke. This case report demonstrated its intended purpose by describing how immediate, intense and frequent PT and patient motivation can lead to significant improvements in balance, gait, and overall strength. The interventions applied, LE strengthening, BWSTT, gait and balance training, were based upon research evidence that linked positive outcomes for post-stroke patients and their recovery. In the studies conducted by Dunning et al[20] and Lindquist et al,[4] their research concluded that the use of FES facilitated ankle dorsiflexion activation during gait to decrease foot drag, improving gait speed and mechanics. The patient in this case report was given similar interventions during his gait training. He had FES on his LLE to improve his dorsiflexion during swing phase. He demonstrated improvements in gait by being able to walk without foot drag with an assistive device at the end of his four-week inpatient rehabilitation stay.

Certain factors may have contributed towards the patient's positive outcomes, including his determination, prior LE strength, family support, access to updated equipment, and his intensive interprofessional medical management provided to him at the IRF. Possible inhibiting factors impeding his recovery were his BMI, tobacco use disorder, and severe expressive aphasia. The limitations of this study were that the results were only found for one young, patient who had a sub-acute stroke. The type and intensity of the interventions and equipment used may not apply or be available for patients with chronic stroke, or patients treated in different PT settings.

The rationale for the patient's success can ultimately be attributed to his immediate care,

access to equipment, and intense treatment from an interdisciplinary team. Although this patient was successful, not all patients will demonstrate the same tolerance or receptibility to his interventions. Thus, more research is needed to investigate the outcomes of the interventions utilized on a greater population with varying ages and impairments to conclude which interventions are most successful for treating stroke.

As the literature proclaims, immediate physical therapy following a stroke gives the patient the best opportunity for a quicker recovery rate;[17] which was demonstrated by this patient. This patient began PT six days after his stroke, and was treated for four weeks, at least five days a week, with intense PT, OT, and SLP interventions. He appeared to benefit from this type of therapy and demonstrated significant improvements towards achieving his goal of regaining independence and walking. This patient not only had intense immediate therapy, but also had access to high quality equipment and resources, and an interdisciplinary team. Other patients may demonstrate similar improvements if they are fortunate enough to have the accessibility to the care and resources that this patient had. Overall, a patient's motivation, age, past functional ability, and accessibility to PT and equipment should be considered when determining which interventions would be most suitable for their recovery. Generally, faster recovery can be seen for patients with sub-acute phase stroke compared to patients with chronic stroke. In conclusion, the efficacy of the interventions utilized for this for patient should be further investigated for patients with chronic stroke, patients in various PT treatment settings, and for older patients who have had a stroke.

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379 **TABLES and FIGURES**

380 Table 1: Systems Review: Initial Evaluation
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Cardiovascular/Pulmonary	**Impaired:** - Decreased endurance, sleep apnea - Regular rate and rhythm. Peripheral pulses: 2+ bilaterally. Brisk capillary refill.
Musculoskeletal	**Impaired:** - Decreased gross motor strength in upper and lower extremities - Decreased AROM and PROM in L LE/UE - Impaired gait and transfers - Decreased WB on LLE - Mild bilateral edema in extremities.
Neuromuscular	**Impaired:** - Decreased sitting and standing balance - Impaired sensation: light touch, and proprioception in LLE: L3-4 Diminished sensation on L side of face - Impaired CN: 5,7, 11 - Abnormal deep tendon reflexes: left biceps tendon, triceps tendon, patellar tendon, and Achilles tendon 1+ - Absent clonus and Babinski - Impaired UE/LE extensor tone: spasticity, Modified Ashworth Scale = 2 - Coordination: intact: no dysmetria or dysdiadochokinesis
Integumentary	**Impaired:** - Skin diffuse morbilliform rash on anterior chest, back, UE, proximal thigh levels
Communication	**Impaired:** - Significant expressive aphasia, some receptive aphasia - Dysarthric speech when able to verbalize
Affect, Cognition, Language, Learning Style	**Impaired** - Affect: flat affect, cooperative

	- Memory: retrieval memory impaired - Speech: non-fluent, comprehension, but unable to repeat **Intact:** - Attention (sustained alternation, divided) and concentration - Orientation 3x (person, place, time) - Language: normal

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383 Table 2: Examination Tests and Measures

Tests and Measures	**Initial Evaluation Results**	**Discharge Results**
Gait	- Unable to perform	- 250’ w/ hemi-walker w/ min A. - 90’ w/o assistive device w/ min A.
Stair Climbing	- Unable to perform	- 12 stairs w/ min A.
Dermatomes	- light touch, and proprioception in LLE, L3-4 - Diminished sensation on L side of face	- Intact light touch, proprioception, and facial sensation
Deep Tendon Reflexes	- Abnormal deep tendon reflexes: left biceps tendon, triceps tendon, patellar tendon, and Achilles tendon 1+	- Normal DTR: 2+ bilaterally
Modified Ashworth Scale	- UE/LE extensor spasticity: 2	- UE/LE extensor spasticity: 1
Transfer Screening	- Maximum Assistance	- Supervision/minimum assistance
Balance: sitting & standing screening	- PASS: 6/36	- PASS: 34/36

Manual Muscle testing: Left UE/LE

	Initial evaluation	Discharge
Shoulder Flexion	1/5	2-/5
Shoulder Extension	2-/5	3/5
Elbow Flexion	2-/5	3/5
Elbow Extension	2-/5	3/5
Wrist Flexion	0/5	1/5
Wrist Extension	0/5	1/5
Finger Flexion	2-/5	3/5
Finger Extension	0/5	1/5
Hip Flexion	2/5	4/5
Hip Extension	2/5	4/5
Hip Abduction	3/5	4+/5
Hip Adduction	3/5	4+/5
Knee Flexion	2/5	4/5
Ankle Plantarflexion	2/5	4+/5
Ankle Dorsiflexion	1/5	3+/5

Manual Muscle Test Scoring: 0/5: no visible or palpable contraction. 1/5: visible or palpable contraction (no ROM). 2-/5: partial ROM, gravity eliminated. 2/5: full ROM, gravity eliminated. 2+/5: gravity eliminated/slight resistance or < ½ range against gravity. 3-/5: > ½ but < Full ROM, against gravity. 3/5: full ROM against gravity. 3+/5: Full ROM against gravity, slight resistance. 4-/5: full ROM against gravity, mild resistance. 4/5: Full ROM against gravity, moderate resistance. 4+/5: Full ROM against gravity, almost full resistance. 5/5: normal, maximal resistance. [9]

*UE assessments performed by occupational therapist

Table 3: National Institute of Health Stroke Scale: Inpatient Rehabilitation Evaluation

Item	**Scale**	**Score**
Level of Consciousness	Alert	0
Level of Consciousness Questions	Answers neither question correctly	2
Level of Consciousness Commands	Performs both tasks correctly	0
Best Gaze	Normal	0
Visual	No visual field loss	0
Facial Palsy	Minor paralysis	1
Motor Arm	5a: Left arm →drift 5b: right arm → normal	1 0
Motor Leg	6a: left leg → some effort	2

	against gravity 6b: right leg →normal	0
Limb ataxia	Present in one limb	1
Sensory	normal	0
Best Language	Severe aphasia	2
Dysarthria	Severe dysarthria	2
Extinction and Inattention	normal	0
Total:		11: moderate stroke

The scoring: > 25 = very severe, 15-25 = severe, 5-14 = mild to moderately severe, and 1-5= mild.[11]

Table 4: Functional Independence Measure

Items	**Initial Evaluation**	**Third-Day**	**Discharge**
Eating	Minimal Assistance: 4	Minimal Assistance: 4	Modified Independence: 6
Grooming	Total Assistance: 1	Maximal Assistance: 2	Modified Independence: 6
Bathing	Total Assistance: 1	Total Assistance: 1	Supervision: 5
Upper body dressing	Total Assistance: 1	Maximal Assistance: 2	Minimal Assistance: 4
Lower body dressing	Total Assistance: 1	Total Assistance: 1	Minimal Assistance: 4
Toileting	Total Assistance: 1	Maximal Assistance: 2	Minimal Assistance: 4
Bladder function	Supervision: 5	Supervision: 5	Modified Independent: 6
Bowel in night	Total Assistance: 1	Total Assistance: 1	Minimal Assistance: 4
Transfers: bed/chair/wheelchair	Total Assistance: 1	Maximal Assistance: 2	Supervision: 5
Walking/Wheelchair	Does not occur: 1	Maximum Assistance: 2	Minimal Assistance: 4
Stairs	Does not occur: 1	Does not occur: 1	Minimal Assistance: 4
Transfers toilet	Total Assistance: 1	Total Assistance: 1	Supervision: 5
Tub & Shower transfer	Total Assistance: 1	Total Assistance: 1	Supervision: 5
Comprehension	Modified Independence: 6	Modified Independence: 6	Complete Independence: 7
Expression	Maximal Prompting: 2	Minimal prompting: 4	Minimal Prompting: 4
Social interaction	Modified independence: 6	Complete independence: 7	Complete Independence: 7
Problem solving	Standby-prompting: 5	Standby-prompting: 5	Modified Independence: 6
Memory	Minimal prompting: 4	Modified Independence: 6	Modified Independence: 6
totals	44/126	53/126	92/126

The scoring goes as follows: 7: complete independence, 6: modified independence (device), 5: supervision (subject 100%), 4: minimal assistance (subject 75% or more), 3: moderate assistance (subject 50% or more), 2: maximal assistance (subject 25% or more), 1: total assistance (subject less than 25%).[12]

Table 5: Postural Assessment Scale for Stroke Results[13]

Items	**Initial Evaluation**	**15 days post evaluation**	**Discharge**
1.Sitting without support	0/3	3/3	3/3
2.Standing with support	0/3	3/3	3/3
3.Standing without support	0/3	3/3	3/3
4.Standing on nonparetic leg	0/3	3/3	3/3
5.Standing on paretic leg	0/3	1/3	2/3
6.Supine to affected side lateral	1/3	3/3	3/3
7.Supine to non-affected side lateral	1/3	3/3	3/3
8.Supine to sitting up on edge of the table	1/3	3/3	3/3
9.Sitting on the edge of the table to supine	1/3	3/3	3/3
10.Sitting to standing up	1/3	2/3	3/3
11.Standing up to sitting down	1/3	3/3	3/3
12.Standing, picking up a pencil from the floor.	0/3	1/3	2/3
Totals	6/36	21/36	34/36

Table 6: Physical Therapy Goals

Time Frame	**Goals**	**At discharge**
Short term goal: 2 weeks	Patient will be able to complete a stand pivot transfer from his manual wheelchair to the edge of the bed with moderate assistance.	Goal met
Short term goal: 2 weeks	Patient will be able to ambulate level surfaces in the parallel bars 10 feet with moderate assistance	Goal met
Short term goal: 2 weeks	Patient will be able to stand with an assistive device for one minute with minimal assistance.	Goal met
Long term goal: 4 weeks	Patient will be able to ambulate level surfaces with the least restrictive assistive device for greater than 150 feet.	Goal met
Long term goal: 4 weeks	Patient will be able to navigate 12 stairs with minimal assistance.	Goal met
Long term goal: 4 weeks	Patient will be able to complete a stand pivot transfer with a hemi-walker from his chair to the edge of the bed with supervision.	Goal met

APPENDICES

Appendix 1: Inpatient Rehabilitation Medication List

Medication	**Amount / Frequency**	**Usage**
Aspirin	81 mg / 1 tab, oral, daily	To prevent blood clots.
Atorvastatin	80 mg/ 2 tabs, oral, QHS	Lower bad cholesterol
Baclofen	5 mg/ .5 tab, oral, QHS	Muscle relaxant and antispasmodic agent
Cyanocobalamin (Vit B12)	500 mg / 5 tabs, oral daily	Vitamin B12, maintain health of metabolism, blood cells and nerves.
Enoxaparin (Heparin)	40 mg / .4 mL, subcutaneous, daily	Used to prevent and treat DVT or pulmonary embolism.
Folic acid	1 mg / 1 tab, oral, daily	Lower homocysteine levels to prevent heart disease or stroke.
Mirtazapine	7.5 mg / .5 tab, oral, QHS	Antidepressant
Ticagrelor (Brilinta)	90 mg / 1 tab, oral, Q 12 hr.	Help prevent heart attack or stroke.
Lidocaine topical	unknown	Decrease pain
Nicotine gum	unknown	Agent to help quit smoking.

Appendix 2: Validity and Reliability for Tests and Measures

	Reliability	Validity
NIHSS[21]	R= .977	Construct Validity: excellent
FIM[12]	R= .94-.98, ICC=.8-.99	unknown
PASS[13]	R=.73	Construct Validity: good compared with FIM.
MMT[22]	Good Reliability	Good Validity
Modified Ashworth Scale[12]	Excellent intra-reliability for UE, and adequate for LE.	Convergent validity: excellent compared to the Fugl-Meyer.

417 Appendix 3: Interventions

	Week 1	Week 2	Week 3	Week 4
Balance training	• Standing weight shifting & marching in parallel bars with mirror for patient feedback (5-10min). (M-Th) • Sit to stand transfer training repetitions (3x20) (M-F)	• Standing lateral weight shifting, staggered stance weight shifting, forward step onto 4" step (10min). (M, Tu) • BWS dynamic balance training w/ toe taps & perturbations. (W) • Dynamic standing balance onto inverted BOSU for ankle stability (2x20, F)	• Toe-taps onto 6" stair 3x20 bilaterally (Th, F) • Toe-taps onto 3 different heights (6",9",12") bilaterally, 3x20 (M-Th) • Sit to stand transfer training repetitions (3x20) (M-F)	• Toe-taps onto 3 different heights (6",9",12") bilaterally, 3x20 (M-W) • Transfer from wheelchair into bed, to mimic bed height at home (29" off ground, M-Tu) • Car transfer, into and out of car (W)
Therapeutic exercise	• Supine on therapy mat: SAQ over bolster, ankle pumps, hip abd/add, bridging, clamshells (3x20 Tu-F)	• Supine on mat: hip/knee flex/ext, SAQ over bolster, ankle pumps, bridges, hip ABD/ADD (3x20, Tu, Th) • Nu-step recumbent bike, with 3 resistance (15 min, Th, F)	• HIP IR/ER active range of motion, supine "clock" rotation, 3,12,9 o'clock, w/ overstretch (4 min, M) • Roll medicine ball anteriorly/posteriorly 2x20 w/ LLE (M). • Seated exercises: marching for hip flexion, ankle pumps, hip abd/add, LAQ. 3x20 bilaterally. (Tu) • Nu-step recumbent bike (15 min, 10 resistance, Tu) (10 min with 10 resistance, W), (10 min w/ 12 resistance Th, F).	• Nu-step recumbent bike (15 min, 10 resistance (M-W)) • Stairs, ascending and descending (16 x 4x6" stairs M-W)

Gait training	• Walking in hallway with RUE support, mod A, LLE wrapped with ace wrap for DF (2x20' M), (3x20 Th), (73x3 F)	• Walking in hallway, min A, RUE support (5x50', M) • Walking w/ hemi-walker (HW), mod A w/ Bioness L-300 LLE for DF, (50',75', Tu) (60',35' Th) (125', 190', 160' F) • Body Weight Support Treadmill (BWST) 15 min @ .9-1.2 speed. (W)	• Walk w/ Bioness L300 with HW (90', 60', 75',70', 55', 115' touch assist, M) • Walk w/ Rolling Walker w/ ace wrap over LUE & w/ Bioness L300 (90', 75', 90', M), (135', Tu) • Walking with rolling walker w/o Bioness, touch assist (350', 122', 100', Th), (350', 112', F) • Walking with HW w/o Bioness, w/ touch A (200', Th), (234', 155', 261', 275' F) • Stairs ascending and descending with touch A, 12 4x6" stairs. (Th, F) • Walking w/o assistive device, min A (65', F)	• Walking w/o an assistive device, touch A (200', 150', M), (150', 300' Tu), (500'x2 W) • Walking with HW w/o Bioness, w/ touch A (250'x2 M) (500', 350' Tu) (1000' W)
Neuro-muscular re-education	• Motomed 15 minutes (M, T, F)	• Motomed 15 min (M) • Neuromuscular Electrical stimulation (NMES) on anterior tibialis for DF (10 min, 10/10 cycle, 60 mA, Tu)	• Neuromuscular Electrical stimulation (NMES) on anterior tibialis for DF (10 min, 10/10 cycle, 70 mA, Tu) (15 min, 10/10 cycle, 61 mA, W)	

Key: Monday (M), Tuesday (Tu), Wednesday (W), Thursday (Th), Friday (F), Weight (wt), abduction/adduction (abd/add), Neuromuscular electrical stimulation (NMES), minimal assistance (min A), moderate assistance (mod A), Motomed (stationary bike with motor), Nu-step (recumbent bike/elliptical), Hemi-walker (HW), Rolling walker (RW), Right upper extremity (RUE), Left lower extremity (LLE), short arc quad (SAQ), long arc quad (LAQ), with

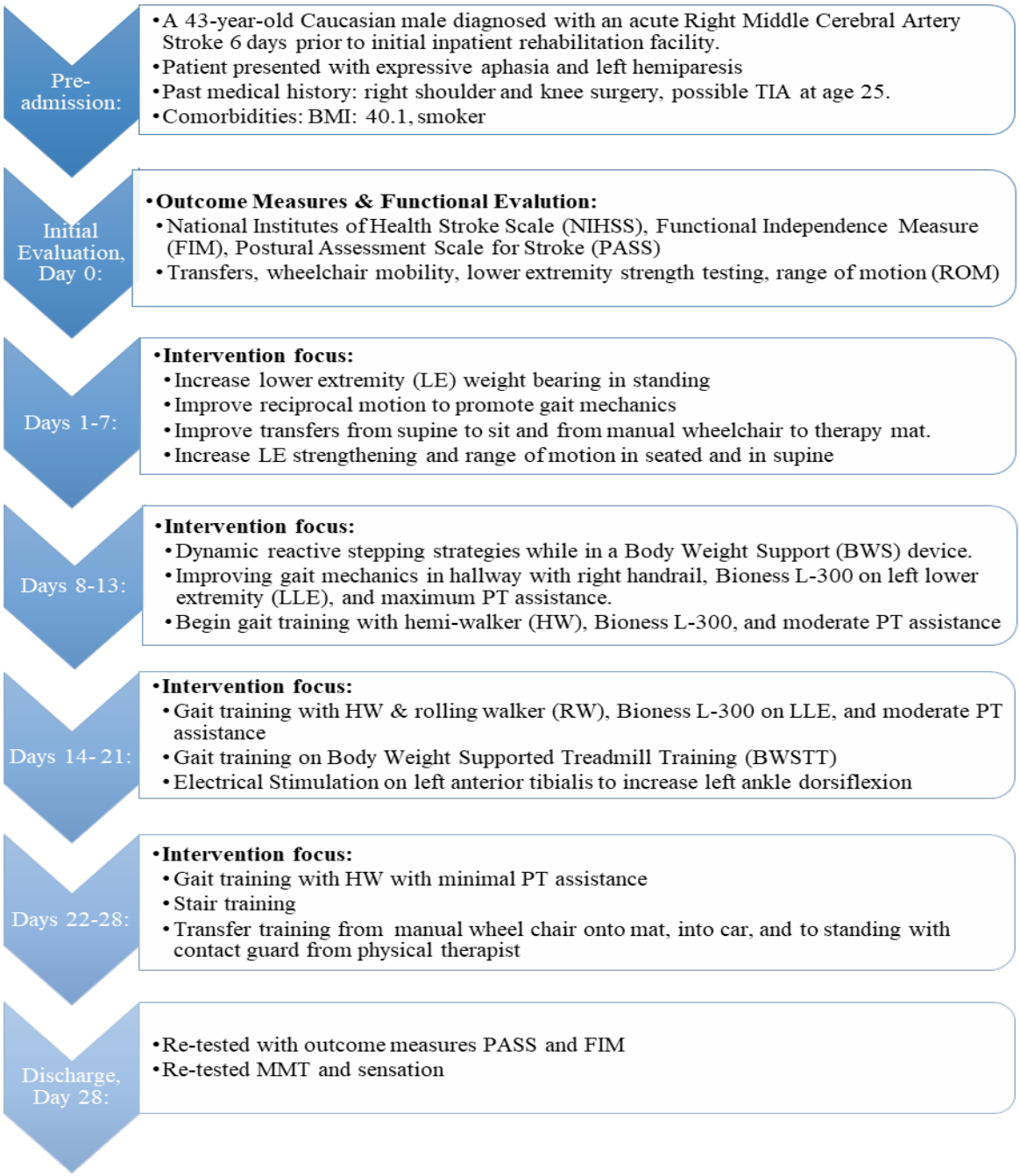
(w/), without (w/o).

Appendix 4: Details/highlights of intervention progression:

Balance training:	• Patient began week one with weight shifts in the parallel bars with moderate assistance from physical therapist to promote weight bearing and balance on the affected limb, using a mirror to self-correct posture. • Patient progressed in week two to dynamic balance and perturbation in a body weight support system to improve balance. • Patient began toe-taps onto higher heights in week three to improve dynamic balance, stability, and endurance levels. • Patient continued dynamic balance exercises, and practiced transfers onto higher surfaces to challenge coordination.
Therapeutic Exercises:	• Patient completed supine therapeutic exercises in week one because patient could not maintain sitting balance. Exercises helped to improve lower extremity strength and coordination to promote functional mobility and gait mechanics. • Patient progressed in week two to completing series of seated therapeutic exercises. Patient began to utilize Nu-step to promote reciprocal motion and lower extremity endurance and strength • Patient continued in week three with a variety of lower extremity exercises to improve lower extremity strength and active range of motion in a seated position. • Patient completed increased repetitions of stair navigation with minimal assistance and increased resistance and time on the Nu-step to promote cardiovascular training and lower extremity strength.
Gait:	• Patient began walking in hallway with ace wrap on left ankle to assist with dorsiflexion on left lower extremity, with moderate assistance from physical therapist in week one. • Patient used body weight support treadmill training (BWSTT) to assist with walking, with moderate assistance from physical therapist for left lower extremity advancement in week two. • Patient began walking with hemi-walker and rolling walker with left upper extremity ace wrapped to handle of the rolling walker, and with the Bioness L300 on left lower extremity to assist with dorsiflexion during swing phase of gait during week 2 with minimal to moderate

	assistance from physical therapist. • Patient began walking with a hemi-walker and rolling walker without the need for the Bioness L300, with minimal assistance from physical therapist in week three. • Patient began walking without an assistive device with minimal assistance for stability at the end of week three and into week 4.
Neuromuscular re-education	• Patient propelled Motomed bike actively/passively during week one and two to promote reciprocal movement and active range of motion in lower extremities. • Patient was given NMES on left lower extremity to activate anterior tibialis to promote dorsiflexion and prevent foot drop during gait in week two and three.

442 Appendix 5: Timeline



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